

# MISR Level 1 Products Quality Statement June 5, 2005

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## Quality Designator:

- **Stage 2 Validated:** Radiometric Camera-by-camera Cloud Mask (RCCM) over ice-ocean
- **Stage 1 Validated:** L1B2 Terrain Radiance (Global/Local), L1B2 Ellipsoid Radiance (Global/Local), Geometric Parameters, L1A CCD, L1B1 Radiance, RCCM over snow and ice-free land

[MISR maturity level definitions](#)

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This statement applies to MISR Level 1 Products with a version number of 0024. See the [Versioning Page](#) for an in-depth explanation of the differences between various MISR product versions. Quality statements covering earlier time periods may be accessed through [links](#) at the bottom of this page.

The MISR Level 1 software which generated these products is believed to be functioning quite well except where noted below. This statement lists known problems with Level 1 Products and clarifies issues which have confused some users.

### Geometric Parameters (a.k.a GP\_GMP, MIB2GEOP) (from MISR PGE7) (Validated)

There are no known problems with the current release of PGE7 software. Analysis of isolated case studies indicates that the software is meeting all of its requirements.

The Geometric Parameters exhibit one algorithmic quirk which has surprised some users. Solar zenith and azimuth angles near the swath edge occasionally appear to jump around. This inconsistency is the result of an intentional choice of algorithm whereby solar angles are computed at the mean time at which MISR cameras viewed the ground point in question. Adjacent points are not always visible to the same set of cameras. This can cause a bias in solar angle towards cameras which acquired that point.

**L1B2 Terrain (a.k.a. GRP\_TERRAIN\_GM, MI1B2T) (from MISR PGE1) (Stage 1 Validated)**

**L1B2 Ellipsoid (a.k.a. GRP\_ELLIPSOID\_GM, MI1B2E) (from MISR PGE1) (Stage 1 Validated)**

**Local Mode (a.k.a. GRP\_TERRAIN\_LM, MI1B2T) (from MISR PGE6) (Stage 1 Validated)**

**L1B2 Ellipsoid Local Mode (a.k.a. GRP\_ELLIPSOID\_LM, MI1B2E) (from MISR PGE6) (Stage 1 Validated)**

This portion of the list is lengthy, so the sub-headings are listed for quick reference.

- [RADIOMETRIC CALIBRATION](#)
- [GEORECTIFICATION and COREGISTRATION](#)
- [EXCEPTIONS/ANOMALIES](#)
- [ELLIPSOID COLOR BROWSE](#)
- [Level 1A](#)
- [Level 1B1 including Local Mode](#)
- [RCCM \(Cloud Mask\)](#)

## RADIOMETRIC CALIBRATION

The MISR calibration team has been involved in an on-going effort to both validate and make incremental improvements to the radiometric accuracy of the Level 1B data products. Because the uncertainties in these products are well understood, those versioned 0012 or greater, are given the quality designation of "Stage 1 Validated."

**Update:** The MISR band-relative radiometric calibration has been improved for Level 1 products of version 0022 or greater. Red band radiances have been reduced by 3% for all cameras, and NIR band radiances have been reduced by 1%. The need for a change was



discovered during analysis of data from several MISR vicarious calibration experiments. Results from MISR vs MODIS, MISR vs MERIS and Terra lunar calibration studies supported the decision to make this change.

Radiometric accuracy has been improved for products versioned 0015 or greater. The improvement was achieved by discovering and correcting an error in the code used to derive the radiometric calibration coefficients. A-Nadir camera data produced before this date may have had absolute errors as large as 10% (too bright) at the left/western edge of the scene, and -5% (too dim) at the right/eastern edge. Radiometry at the swath center, and for other cameras has been in error to a lesser degree. Descriptions of calibration uncertainties for older products can be found on the [Calibration Page](#). The uncertainties at this time are listed below.

- The **absolute uncertainty** in MISR radiances is estimated to be within 4% (1 sigma level of confidence) for bright uniform targets.
- **Camera and band-relative uncertainties** are within 2%.
- **Pixel-relative uncertainties** are within 0.5%. It is noted that vertical striping has been displayed in selected scenes, such as highly contrast-enhanced images of uniform snow, ocean, and desert regions. It has been verified that the peak-to-valley radiance difference for these scenes is less than 0.5%.
- **Early mission data** (February - March, 2000) have increased uncertainties. During this time period, the MISR radiometric response was rapidly changing, due to an initial instrument on-orbit settling effect. This change has been noticed in most other on-orbit sensors, and is generally attributed to the browning of the optics in the space environment. Thus, products generated prior to the ARP T002 time era (April 27, 2000) may contain radiometric errors as large as 10%.
- **Scene-dependent errors.** Although MISR radiometric accuracy is predictable over uniform targets, this is not so for contrast scenes. Improved radiometry for these cases is achieved through the use of a point-spread-function (PSF) correction for products versioned 0016 or greater. Additional scene-dependent errors may result from ghost-image effects. Here, a secondary image, reflected about the lens optical axis may appear. The magnitude of this ghost is estimated to be 0.3% of the scene brightness. Although small, a ghost image of a bright target can reflect into a dark ocean body, causing undesirable errors over the dark water. Table 1 elaborates on known sources of scene-dependent errors.

Table 1. Sources of scene-dependent effects

<b>PSF</b> effects refer to scene-contrast reductions due to local scene inhomogeneity. The radiometry of one pixel is affected in proportion to the contrast difference and proximity of another pixel. This is a camera optical effect, and is measurable for objects that are within 6 km crosstrack distance of each other. The downtrack PSF effect is believed to be negligible. A deconvolution algorithm is now exercised in the software to minimize PSF effects.
<b>Ghost-image</b> refers to the presence of a secondary image, created as a reflection of a given target through the lens optical axis. This secondary ghost has been measured to be 0.3% of the primary image, and thus results in a negligible error except where the image of a bright target falls on a very dark scene.
<b>L1B2 resampling</b> is implemented by bilinear interpolation, and thus errors in this process are a function only of a sample's radiance value as compared to that of its immediate neighbors.
<b>Illumination-level</b> dependent errors are attributable to the goodness-of-fit of camera response data to a mathematical equation. The MISR cameras are described as having a linear relationship between incident radiance and camera output. For radiance levels less than 2% in equivalent reflectance, this assumption is valid to within 5% uncertainty. The error is considered negligible for larger input signals.
<b>Detector uniformity of response</b> errors occur when a set of detector elements are non-uniform in response (10% non-uniformity or greater), are image inhomogeneous scenes, and are DN-averaged as part of the on-board data compression (Global Mode) algorithm. Only a dozen detector regions (out of 13,000 such pixel blocks) are non-uniform, and these are identified by data quality indicators in the products. For conditions where bright scenes are adjacent to dark scenes, an additional radiometric error of 6% may result in pixel regions where the Data Quality Indicator level is given a value of 2.

GEORECTIFICATION and COREGISTRATION

**Update:** MISR Level 1B2 products exhibit as expected georectification and coregistration accuracy. In the nominal case, the expected mean geolocation error for all nine cameras is below 20 meters. Standard deviations range between 30 meters for A-Nadir camera, and 70 meters for most oblique D's cameras.

Also, all camera data acquired during occasional spacecraft maneuvers is of degraded accuracy. Data products generated during these times contain an Orbit Quality flag which indicates this problem. The nominal value of the Orbit Quality flag in the File Metadata (Global Attributes) is 0.0. Degraded data has an Orbit Quality flag value of -1.0. See the [Georectification Page](#) for more details, including a link to the list of degraded orbits.

EXCEPTIONS/ANOMALIES

- **GAPS:** The raw MISR data contains occasional gaps. These gaps usually consist of a few lost lines. Straight lines of raw data are resampled to gentle curves in the SOM map projection. Radiances in the gap regions are filled in with pre-defined fill values. Gaps then usually look like narrow, curved, bright, horizontal stripes in the L1B2 image. There is at least one small gap in almost every swath. In rare cases, data gaps of many lines have been observed.
- **INSTRUMENT OUT-OF-SYNC:** The MISR instrument tends to go out-of-sync momentarily if the data rate from the hardware exceeds

the real-time flight computer's capacity to write data out. This condition can occur whenever a change of camera state is commanded. Image lines acquired while the MISR instrument was out-of-sync may contain sporadic fill and/or repeats of previous lines. The resulting image contains a brief vertical smear across the swath. Normally, this phenomenon only lasts for a handful of lines. In order to avoid geolocation errors, interpolated time values are inserted for these lines.

- **TERRAIN TOPOGRAPHIC OBSCURATION:** The line-of-sight between an off-nadir camera and a ground point is sometimes blocked by a topographic feature, such as a mountain. In such cases, fill values are reported instead of radiances in the terrain product. Large patches of obscuration fill can be seen in the D cameras over mountainous regions.
- **TERRAIN OCEAN FILL:** Blocks which encompass no land at all get entirely filled with ocean-fill values in the terrain product. Terrain algorithms are wasteful over ocean since height variation is negligible there. The Ellipsoid product already contains radiances for these blocks. If ocean blocks are required, blocks from the Ellipsoid product may be substituted.

## ELLIPSOID COLOR BROWSE

The Nadir, single-band L1A browse product has been replaced with a new Ellipsoid-based color product. The new browse product is generated for all 9 cameras at 2.2 km resolution (sub-sampled). MISR Red, Green and Blue bands are used to create the color image, which is intentionally clipped and gamma-stretched in order to make cloud, ocean and land features visible. The jpeg compression is performed at 75% quality, which means that compression artifacts are occasionally visible.

## L1A CCD (a.k.a. FM\_SCI, MIL1A) (from MISR PGE1) (Validated)

The MISR Level 1A product is a reformatted version of the raw L0 data packet stream from the spacecraft. In this format, the CCD Data Numbers (DNs) may be viewed as an unregistered image with data quality indicators occupying the two low-order bits. By design, L1A does not differ greatly from the raw data except that gaps are filled in with appropriate fill values.

## L1B1 (a.k.a. RP\_GM, MI1B1) (from MISR PGE1) (Stage 1 Validated)

### L1B1 Local Mode (a.k.a. RP\_LM, MI1B1LM) (from MISR PGE1) (Stage 1 Validated)

The MISR Level 1B1 product has been radiometrically corrected, but it has not been registered. The quality of L1B1 radiances is equivalent to that of L1B2 radiances discussed above, except that L1B1 pixels correspond directly to instrument CCD detector samples.

The L1B1 Local Mode product consists of the L1B1 output acquired when the MISR instrument is put into Local Mode in which all nine cameras view a scene at 275 m resolution in all four bands.

## RCCM (a.k.a. GRP\_RCCM, MIRCCM) (from MISR PGE1)

### RCCM over ice-free Ocean - (Stage 2 Validated)

### RCCM over snow and ice-free land and Glitter Mask - (Stage 1 Validated)

The cloud mask produced during Level 1 processing is called the RCCM (Radiometric Camera-by-camera Cloud Mask). It is one of three independent cloud masks generated from MISR data. The other two cloud masks are produced at Level 2 and are called the ASCM (Angular Signature Cloud Mask) and the SDCM (Stereo Derived Cloud Mask).

The RCCM algorithm applies traditional spectral and spatial measures to data from each MISR camera in order to produce separate cloud masks for each camera. These measures and the threshold procedures are completely different for the two processing paths: ocean and land. For this reason, ocean and land may carry different quality statements. Another field, the Glitter Mask, is included in the RCCM product for the sake of convenience.

Over ocean, the RCCM employs a static threshold procedure. The static thresholds are a function of the sun-view geometry and have been fine-tuned several times since launch. The RCCM thresholds for both land and oceanic scenes were updated for the V3.3 delivery and this has prompted the recent quality transitions to Stage 1 and Stage 2 Validated.

Visual inspection, data from field campaigns, and comparison with other satellite-derived cloud masks have been used for validation. Overall, better than 90% agreement exists between all cloud masks (including the SDCM and ASCM described in the [L2TC Quality Statement](#) over ice-free ocean and better than 85% agreement is observed for all snow-free land surfaces. This statement will be updated to include more specific numbers when the current validation work is complete.

Although overall performance looks good for the RCCM over ice-free ocean, it does suffer from the traditional problems encountered with spectral/spatial cloud masks:

- Very thin clouds may go undetected.
- Thick aerosol layers may at times be classified as cloud.
- Cloud detection over strong sun-glint regions may at times be a problem.
- Sea ice is often classified as cloud.
- Shallow coastal and inland water can cause clear skies to be classified as cloud.

The Glitter Mask indicates regions of the data that may contain sun-glint. As of February 5, 2002, (version 0011) the sun-glint cone angle was increased from 30 degrees to 40 degrees in order to mask some of the weaker glint that was observed in the imagery.



Also see the

- [Statement dated March 10, 2004](#) for MISR Level 1 Products from March 10, 2004 to June 04, 2005.
- [Statement dated December 1, 2003](#) for MISR Level 1 Products from December 01, 2003 to March 09, 2004.
- [Statement dated September 24, 2003](#) for MISR Level 1 Products from September 24, 2003 to November 30, 2003.
- [Statement dated November 12, 2002](#) for MISR Level 1 Products from November 12, 2002 to September 23, 2003.
- [Statement dated October 24, 2002](#) for MISR Level 1 Products from October 24, 2002 to November 11, 2002.
- [Statement dated July 31, 2002](#) for MISR Level 1 Products from July 31, 2002 to October 24, 2002.
- [Statement dated April 15, 2002](#) for MISR Level 1 Products from April 15, 2002 to July 26, 2002.
- [Statement dated February 05, 2002](#) for MISR Level 1 Products from February 05, 2002 to April 14, 2002.
- [Statement dated December 03, 2001](#) for MISR Level 1 Products from December 03, 2001 to February 4, 2002.
- [Statement dated September 27, 2001](#) for MISR Level 1 Products from September 27, 2001 to December 02, 2001.
- [Statement dated March 30, 2001](#) for MISR Level 1 Products from March 30, 2001 to September 26, 2001.
- [Statement dated February 16, 2001](#) for MISR Level 1 Products from December 21, 2000 to March 29, 2001.
- [Statement dated August 24, 2000](#) for MISR Level 1 Products from August 1 to December 20, 2000.
- [Statement dated June 15, 2000](#) for MISR Level 1 Products from June 1 to July 31, 2000.

